It will be observed that the two methods give identical results. By using the new method it is necessary only to use a table of squares and an adding machine, if these are available, and about one-tenth of the time ordinarily used for finding the coefficient of correlation.

If it is desired to get the standard deviations of these series, they are readily obtainable, because the quantities in the denominator are the sums of the squares of the deviations of these measures from their respective averages. We have the following additional formulae:

$$b_1 = r\frac{\sigma_S}{\sigma_R} = \left[\frac{\Sigma SR - nac}{\sqrt{(\Sigma S^2 - na^2)(\Sigma R^2 - nc^2)}}\right]\left[\frac{\sqrt{\frac{\Sigma S^2 - na^2}{n}}}{\sqrt{\frac{\Sigma R^2 - nc^2}{n}}}\right]$$

$$= \frac{\Sigma SR - nac}{\Sigma R^2 - nc^2}$$

$$b_2 = r\frac{\sigma_R}{\sigma_S} = \frac{\Sigma SR - nac}{\Sigma S^2 - na^2}$$

These values in the case of the above illustrative example are 2.18 and 0.436, respectively.

For single series of independent measures, we obviously have:

$$\text{Standard deviation} = \sqrt{\frac{\Sigma m^2 - na^2}{n}},$$

$$\text{Average deviation} = \frac{n(\Sigma m_+ - \Sigma m_-) - \Sigma m(n_+ - n_-)}{n^2},$$

$$\text{Coefficient of variation} = \sqrt{\frac{n\Sigma m^2 - (\Sigma m)^2}{\Sigma m}}.$$

Where possible the solution should be in terms of class intervals rather than in that of the unit of measure.

CLIMATE AND PHOTOGRAPHY.

By H. G. CORNTHWAITE.

[Rockville, Ind., April 16, 1922.]

SYNOPSIS.

The weather or climatic element in photography is an important one, first, because of the wide variations in the strength of daylight with the time of day, season of the year, condition of the sky, with latitude, and with altitude; and, second, because of the important effects of temperature and humidity conditions have on photographic chemical processes.

Camera operators often produce inferior work in an unfamiliar climatic environment, which suggests the desirability of becoming familiar with climatic and weather conditions and their effects upon photographic work and processes.

As with many other forms of human activity, the weather or climatic element is of first importance in photographic work.

The following notes and observations are based on the writer's experience operating a camera under varying climatic conditions.

The more important climatic influences affecting photographic work may be discussed under two heads: *Intensity of sunlight*, and *Weather conditions affecting photographic chemical processes.*

INTENSITY OF SUNLIGHT.

The intensity of sunlight is perhaps the most important climatic condition affecting outdoor speed photography, as it controls the time of exposure. It varies greatly with the season of the year, the time of day, the condition of the sky (cloudiness), with latitude, and to a less degree with altitude.

The diurnal variations in the actinic (photographic) strength of daylight is well known, the light being brightest when the sun is at or near the zenith and dimming rapidly with increasing obliquity of its rays.

The seasonal variation in the strength of daylight is due to the same cause, variations from season to season in the obliquity of the sun's rays. Amateur photographers too often overlook or underestimate the effects of this seasonal variation. A bright late autumn or winter day *looks* about as bright as a similar summer day, but the photographic strength of the light is perhaps twice as great in summer as in late autumn or winter.

Of a similar character are the variations in the photographic strength of daylight due to changes in latitude, the light being strongest in the Tropics and progressively dimming poleward in each direction. Here, too, photographers often fail to make proper allowance for the wide variations in the strength of light due to the varying degree of obliquity of the sun's rays in different latitudes.

Generally speaking, the photographic strength of light increases with altitude, as the air is less dense at higher altitudes and absorbs fewer of the sun's rays, especially the short wave-length rays of greatest photographic strength. At higher altitudes there is also a greater amount of reflected light gathered by the camera lens.

The effects of cloudiness and fog in reducing the strength of daylight are too well known to require comment.

The amount and distribution of rainfall *indirectly* affect the time required for outdoor exposures, especially landscapes, as rainfall controls in large measure the growth, distribution, and density of vegetation, and the light reflected from green vegetation is of weak photographic strength. Desert scenes require much shorter exposures than views in grassy or forest areas.

Heavy rainfall has a surprising effect on photographic exposures. During a heavy tropical downpour an exposure of one-twenty-fifth second with open lens (speed F. 8) was found to be correct, *the light being actually stronger photographically during the heavy downpour than it was in densely cloudy weather without rainfall,* due to the light reflected from the falling raindrops.

Tropical daylight is perhaps twice as strong photographically as summer daylight in latitude 40 and about four times as bright as winter daylight at this latitude. This relationship, of course, does not hold true when winter landscapes are covered with a dazzlingly white blanket of snow.

The light generally is brighter in the Rocky Mountain and Pacific coast sections of the United States than in the Central and Atlantic coast sections. It is much brighter also along the seacoast than inland.

WEATHER CONDITIONS AFFECTING PHOTOGRAPHIC CHEMICAL PROCESSES.

Temperature and humidity are the important weather elements affecting photographic chemical processes. Chemical activity in developing and fixing processes is greatly increased with high temperatures and correspondingly retarded with low temperatures. Photographic films, negatives, and prints deteriorate rapidly under certain climatic conditions, and are preserved indefinitely under other favorable conditions.

Man can endure a high degree of humidity or a high temperature without distress, but there seems to be a *combination* of the two that is peculiarly inimical to human comfort and well-being. The same is true of photographic films and prints, which may be subjected either to high temperatures or high humidity without excessive deterioration, *but not to both in combination.*

Both prints and films deteriorate rapidly in the moist Tropics, due to the combined effects of high temperatures and high humidity. The writer has known an undeveloped exposed film to be ruined from mildew *in five days' time in the Tropics*, whereas in the Temperate Zone an exposed film was carried in the writer's camera for five months in the West (Oregon), six months in the East (New York), and six months in the Ohio Valley before being developed. *Even then it was only slightly damaged from mildew.*

Photographic prints, too, lose their permanence in the Tropics. Rarely will good professional prints withstand two years' exposure to moist tropical conditions without serious damage. It is therefore unsafe to take valuable photographic prints to the Tropics and allow them to remain for any considerable time. However, prints *developed and fixed* under tropical conditions have a much greater permanence in the Tropics than prints developed and printed in the Temperate Zone and subsequently taken to the Tropics.

CONCLUSION.

From what precedes it will be seen that climatic conditions powerfully influence photographic work. The writer has observed much photographic work spoiled or improperly done because the operator was working out of his accustomed climatic environment. A successful camera man should have at least a fair knowledge of climatology and meteorology. In concluding, suitable advice to photographers would be "Know your camera, lens, and shutter, and know also the climatic conditions under which it operates."

ANOMALOUS STORM TRACKS.

By EDWARD H. BOWIE, Meteorologist.

[Weather Bureau, Washington, D. C., April 1, 1922.]

There are to be found in the meteorological textbooks statements to the effect that cyclones are carried along in the general air currents that are assumed to prevail over the region occupied by the cyclone on any particular date; that these general air currents are subject to seasonal changes; and that the tracks of cyclones are subjected to corresponding changes in both the speed and direction of progression. It is in the main true that in the Tropics the cyclones on the first branches of their tracks move west or northwest and that extratropical cyclones move toward the east or northeast. But if individual cyclone tracks are considered, it will be found that the general rule is very often departed from; that cyclones of the extratropical regions often follow very irregular courses; and that marked variations in the speed of progression are not uncommon. Also, that the tracks of tropical cyclones are not symmetrical and like unto parabolas, as stated in the textbooks. It would simplify the work of the forecasters if cyclones, both tropical and extratropical, would behave in an orderly manner, but unfortunately they do not.

Why, after a cyclone has formed and started on its course, it does not pursue an even and orderly course from its birth to its disappearance is a matter not yet solved, but it must be inferred that in some cases, at least, fundamental changes in environment are encountered which cause these perturbations.

Figure 1 shows the path of five exceptionally erratic cyclones. One of these, that of April, 1903, had its origin over the Carolinas and described a loop over the vicinity of Chesapeake Bay; another, that of April, 1910, formed over Arkansas, moved northward to Wisconsin, where it described a loop and finally disappeared over Lake Erie; and another of the same month and year originated over Kansas, moved east-northeastward to the vicinity of Lake Michigan, where it described a loop and then moved southward and finally disappeared over Georgia; another, that of June, 1916, formed over New Mexico, followed what may be regarded as a normal course until it reached the vicinity of Lake Michigan, where it described a loop in its track and after doing so moved eastward in an orderly manner and finally disappeared off the north Atlantic coast. These storms were all of extratropical origin, but in all instances were well defined, and there is little or no doubt as to the accuracy of the charted positions of their centers. There is also indicated on this chart the track of a West Indian hurricane of October, 1910. It formed over the Caribbean Sea, moved north-northwestward, crossed the western end of Cuba, and in that region the center described a loop and after doing so passed north-northeastward in a normal course. As there had been considerable doubt as to the track this hurricane actually followed, it was recently made the subject of a special study, all available data from land observatories and vessels in that region being used in preparing the daily synoptic charts, by the Observatorio Nacional, Casa Blanca, Habana, Cuba, and later by the Weather Bureau, Washington, D. C. The independent studies were in agreement and to the effect that the track followed was essentially that shown on the chart.

The study at Habana of the hurricane of October, 1910, was made by Dr. José Carlo Millás, Director, Observatorio Nacional, assisted by Dr. Carlos Theye, Mr. Manuel Maria Garcia Blanco, and Mr. Miguel Gutierrez. Dr. Millás, in a recent letter to the Chief of the Weather Bureau concerning this study, wrote as follows:

> The following hypotheses have been studied in the effort to explain the bad weather during five days of October, 1910, in the western part of Cuba:
>
> 1. Elliptical form of cyclone.
> 2. Inclination of the axis.
> 3. Loop.
> 4. Bell-shaped parabola.
> 5. Point d'arrêt.
> 6. Two cyclones.
>
> 1. The elliptical form of cycloae, the inclination of the axis, the bell-shaped parabola, and the point d'arrêt can not explain the observed phenomena.
>
> 2. The hypothesis of two cyclones has been also rejected for the following reasons:
>
> (*a*) Due to theoretical reasons, two hurricanes of considerable intensity can not coexist in such close proximity.